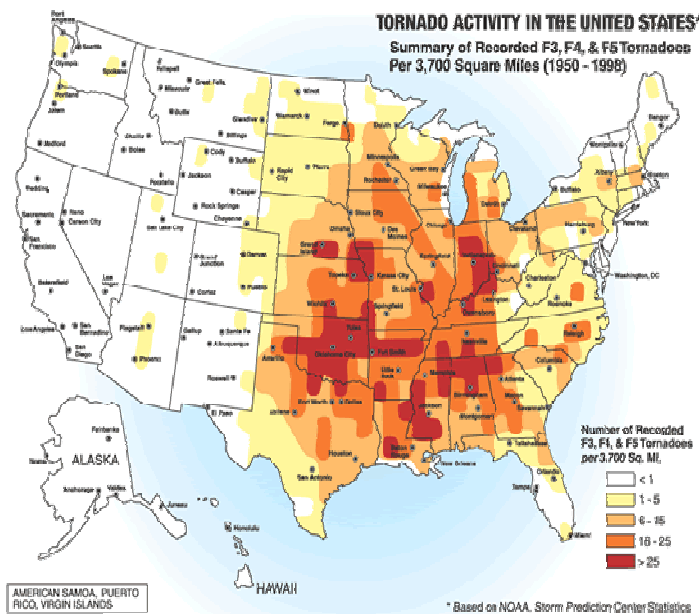


3.0 RISK ASSESSMENT

3.1 Identifying Hazards



Both natural and man-made disasters pose a constant threat to the security of the people and property of the State of Indiana. Due to the idiosyncrasies in Indiana's geography, geology and meteorology the State is at risk for earthquakes, floods, tornadoes/high winds, severe winter storms, and droughts/extreme heat. Other natural hazards, such as subsidence, landslide and wildfire are rare or localized that the risk to the state as a whole is difficult to assess.

Furthermore, according to the USGS website and the Indiana Department of Natural Resources website, there have been no documented subsidences in developed areas of the state. Most of the underground coal mines and the karst topography in the state that would cause these subsidence events are located in southern and south central rural farming areas. This may change as the coal mines are reclaimed and development pressures force the development of these areas. Of the additional natural hazards such as hail which is associated with tornadic type storms and expansive soils which have been identified by the Indiana Geological Survey, but have not produced significant losses in any community, the state has not addressed these because their resulting losses are

1. not tracked
2. never identified by a local as a significant risk
3. no technical feasible way to eliminate the risk to that which is at greatest risk

Indiana is also at risk for some man-made hazards. Often, these man-made hazards occur as a result of the population's quest to control natural resources: i.e. Levees built to protect agricultural land, which due to development now stand between residential or commercial development and floodwaters. Dams to preserve and provide water to the state's communities or to prevent its rivers

from flooding downstream and/or means of transporting themselves and/or their goods throughout the state and across the country are the states most documented man-made disaster. Failure of these dams can destroy a community or its resources. Most of the time, these natural and man-made hazards create only temporary inconveniences to the lives of the citizenry. However, all hazards have the potential to destroy people's homes, communities, economy and lives. The New Madrid earthquakes of 1811 and 1812, the state-wide floods of 1913, 1937, 1964 and 1990, and the tornado outbreaks of 1925, 1965, 1974, and 1982 are only a few examples of the state's vulnerability to natural hazards. This plan will focus on the hazards that pose the greatest risk to the State of Indiana and its citizens. The most threatening hazards identified for the State of Indiana are flood, tornado/straight line winds, winter storm, earthquake and man-made disasters.

The state has experienced twenty-four declared disasters between May 1990 and September 2004. These disasters caused tremendous economic losses and astronomical recovery costs to be incurred by individuals and all levels of government. This large number of events in such a short period of time is unparalleled in Indiana's history and has generated intense interest in mitigation and preparedness planning at all levels of government within the state.

The Indiana State Hazard Mitigation Council (ISHMC) is pursuing the following steps to identify hazards that may affect the state:

- Review of past State and Federal disaster declarations.
- Review of current Flood Insurance Rate Maps.
- Review of available local mitigation plans and hazard analysis documentation. All 92 counties have completed risk assessments as part of the strategic planning goal of the IDHS, and are on file with IDHS's Planning Division. As part of their multi-hazard mitigation plan, many counties are revisiting these risk assessments and updating or improving the information contained in them.
- The use of HAZUS-MH to assess the counties vulnerability for earthquake for this draft and plan to include flooding models in subsequent plans. Currently, the local data is default data provided by the developers, however the state has found that the assessment improves with the addition of better local and state data. Local modeling data has been collected as plans have been developed. As part of the national earthquake planning efforts, the state has gathered additional data and is in the process of finalizing that information as the new local data is being integrated.

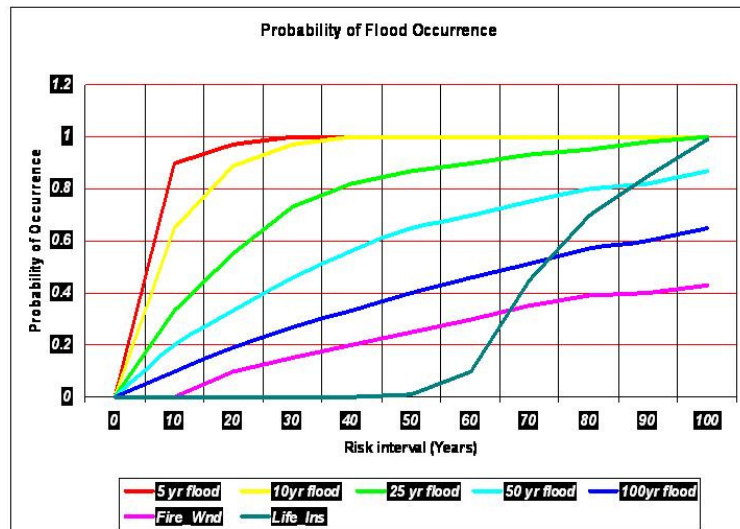
- Review of risk assessment information from various state universities, state agencies, the National Weather Service statistical information, and private contractors.
- Review of information provided by recent geological studies that were conducted as a cooperative effort between IDHS and the Indiana Geological Survey.

As result, IDHS and the ISHMC determined that the state mitigation plan needed to address the risks associated with the following hazards:

- Flooding/Dam and Levee Safety
- Tornadoes/Straight-Line Winds
- Earthquakes
- Winter Storms
- Man-made events (IDHS Mitigation will address this issue briefly, but will mainly reference Indiana's Comprehensive Emergency Management Plan and IDHS Homeland Security Division).

Flooding is the most widespread and significant natural hazard in Indiana and throughout the United States. Major flooding occurs within the state almost every year, and it is not unusual for several floods to occur in a single year.

Stream and lake flooding hazards typically result from excess precipitation run off, excess sewer and local drainage channel backwater, deposition of materials or debris in stream channels during flood events, rise of ground water coincident with



The probability of collecting on a flood insurance policy in a 5, 10, 25, 50 or 100 year flood zone compared to collecting on common insurance policies.

increased stream flow, and other problems. The first type of stream or lake flooding that occurs in Indiana is flash flooding. This type of flood occurs in all areas of the state. They can happen at any time of the year, but happen most frequently in the spring and summer months. The second type of stream flood event that occurs in Indiana is river basin or riverine flooding. This flooding is most common during winter and early spring. It usually takes place along Indiana's major streams and rivers, particularly the Ohio, Wabash, Mississinewa, Kankakee and White. This type of flooding has often caused serious damage in many Indiana counties. Lake flooding that affects Indiana is a more type of gradual flooding. This type of flooding affects the city of LaPorte (Pine Lake) on a somewhat regular basis. Pine Lake is a closed-basin, glacial lake with no natural outlet. This flooding is caused by a rise in the area's ground water. The increased lake level has repetitively damaged several lakeshore homes located in the floodplain.

Dam and Levee Safety is an issue of growing national, regional and State importance. Dams are inherently hazardous structures because of energy that can be released by elevated/stored water. Many dams and levees in the State have deficiencies that will result in an emergency situation leading to a possible breach failure during an unusual loading condition such as a substantial rainfall event.

If dams or levees fail issues of primary concern include loss of human life/injury, downstream property damage, lifeline disruption (of concern would be transportation routes and utility lines required to maintain or protect life), loss of

resource purpose and benefits, and environmental damage. Further, the threat of dam or levee failure requires substantial commitment of time, personnel, and resources.

Since dams and levees deteriorate with age, minor issues become larger compounding problems and the risk of failure increases. Further, the downstream areas become more populated and developed risking more lives and property, and escalating mitigation and rehabilitation costs. Like many critical infrastructure projects, dams and levees are also potential terrorist targets.

Floodplain areas around lakes and along streams, and areas thought to be protected from flood events, may also experience dramatic inundation if levees or earthen berms fail during the stress of flood events. There are a few levee systems in the State that are true flood protection structures. Many levees, however, present a significant hazard because their presence seems to provide a false sense of security. Many of them were built only for small flooding agricultural protection, in areas that have since had residential development.

Examples of media attention regarding levee emergencies that came to recent memory include:

- Flood response sandbagging of levees during flooding in Fort Wayne.
- The Indianapolis water canal levees, an uprooted tree breached the levee and downtown Indianapolis had its water supply threatened.
- In 1990, a 600 foot long levee failure that took out a county road and the town of Petersburg's water supply along the White River.
- Another levee failure in 1996 destroyed a mobile home and again threatened the water supply of Petersburg.
- The Hazelton levee emergency in 1991 (and again in January 2005), White River threatened several dozen homes, a state and federal response and a sand bagging averted disaster.
- The Marion and Johnstown Indiana levee breach, August 1998, along the Mississinewa River.
- The Elnora levee along White River in, Daviess County, near breaches during several flooding events leads to its recent complete reconstruction.
- The Wicker Park Levee, along the Little Calumet River in Lake County, 1990, caused flooding of 270 houses and the complete reconstruction of the levee.
- The Sumava Resorts levees on the Kankakee River, Newton County, on-going issue any time this river raises.
- The Ohio River levees, in Cannelton and Tell City, during an event in 1997, were examples of actual flood control levees that have not been maintained properly and were exhibiting extreme stress in a flood which was much lower than the design level.
- January, 2005 flooding along the White and Wabash Rivers, levels that had not been seen since 1913 caused numerous collapses of

“agricultural” levees. Most of these levees were built as part of the WPA works projects during the 1930’s and were meant to protect crops. These failures did prevent levees in developed communities such as Hazelton with similar levees.

The failure of a dam or an important component of a dam may cause substantial flood damage. Dams are classified by the Hazard they present to downstream property and life, if they were to fail (the classification does not indicate the state of disrepair or the likelihood of failure).

- *High Hazard Dam* - where failure may cause loss of life, serious damage to homes, industrial and commercial buildings, important public utilities, main highway, and railroads.
- *Significant Hazard Dam* - in predominantly rural or agricultural areas where failure may damage isolated homes, main highways, minor railroads, or cause interruption or use of relatively important public utilities.
- *Low Hazard Dam* - in rural or agricultural area where failure may damage farm buildings, agricultural land, or township and county roads.

Depending on the size of an impoundment and the severity of a dam failure, the flood inundation area may be substantially deeper and larger than areas identified as 100-year flood plains for insurance purposes. The lack of the flood insurance flood plain maps to account for inundation due to dam failure is a problem common to all 75,000 plus regulated dams in the United States.

In Indiana the Department of Natural Resources (IDNR) Dam and Levee Safety Branch regulate dams in the State of Indiana. There are about 500 low hazard, 250 significant hazard and 240 high hazard dams that DNR regulate. The numbers change with time as owners decide to remove them from DNR’s jurisdiction and/or downstream hazards change. There are also about 100 control structures that maintain pool levels on many of the lakes in northern Indiana. Although these control structures (considered low hazard) fall within DNR’s jurisdiction, the Division of Water’s Project Development section monitors these structures.

As the dam building era was more than 40 years ago, the inventory of dams is greatly aging and dams are deteriorating. Component and total failures of dams are becoming more common in the State. Additionally, with time residential development continues to increase near water resource features, thus increasing the number of individuals and property at risk due to dam failures. This development also is causing the hazard classification of existing dams to creep up. Dams that were designed and built to function as low hazard structures, because of uncontrolled downstream development now function as high hazard dams.

Some examples of media and/ or state attention regarding dam emergencies include:

- Lake McCoy Dam -- Decatur County, a high hazard dam with repeated failures.
- Beanblossom Dam
- Raysville Dam -- Henry County, a high hazard dam with extreme neglect and deterioration.
- Sylvan Lake Dam -- Noble County, a high hazard dam with a continuing history of deficiencies and component failures.
- Scottsburg water supply reservoir -- a high hazard dam, after 12 inches of rain, the concrete emergency spillway was totally destroyed, the earthen dam embankment was sand bagged and complete disaster narrowly averted.
- Hamilton Lake -- Stueben County, a high hazard dam, 8" of rainfall in about 12 hours, the dam overtopped, quick action by DNR, INDOT and IDHS averted failure of the highway that had become a temporary dam.
- Goshen pond dam
- Grandview dam -- Bartholomew County, a 50 + foot high hazard dam where the embankment cracked down the centerline resulting a failure of the slope. Quick action by the owner's engineer and contractor saved the stabilized the dam.
- Lake Schaffer -- Bartholomew County, a significant hazard dam with a seriously inadequate spillway has nearly overtopped several times in the last 10 years. The lake level has been lowered to reduce the risk of an overtopping failure.
- Hurshtown reservoir -- Allen County, embankment slope instability problems have resulted in several instances of immediate attention and concern on this off-channel high hazard reservoir.
- Centre Grove Dam -- Johnson County, although this high hazard dam had been reconstructed the failure of the principal spillway pipe threatened the structure and required an emergency drawdown of the lake.
- Wagnor Youth Camp Dam -- Grant County, failure of the concrete spillway on this high hazard dam resulted in emergency repairs.
- Brush Creek Dam -- Jennings County, the development of a sinkhole near the toe of slope on this high hazard dam resulted in the lowering of the lake and implementing` a detailed monitoring program and developing an extensive reconstruction plan.
- Lake Salinda Dam -- Washington County, the failure of a portion of the concrete ogee spillway resulted in an unscheduled response by state officials and the governor. A temporary emergency measure of placing fill downstream of the failed spillway and lowering of a water supply lake was required.

Even the best of the best dams can have problems. Two federal dams, which are examples of conservatively designed and built structures, have recently experienced substantial problems.

- Patoka Reservoir -- sinkholes formed with underground voids in the emergency spillway, this resulted in a multi million dollar repair.
- Mississenewa Reservoir -- piping under the embankment is causing displacement of embankment fill material and significant settlement. This lake level has been lowered for at least 3 yrs, and repairs are estimated at \$55 million for a cutoff wall through the embankment into bedrock.

At the present time, the State of Indiana does not have all the data needed to assist in the prediction of the probability of dam failure. Such data will be made available upon completion of the inundation mapping for the dams throughout Indiana. (See project 10 in Section 4 of this document.)

Tornadoes also pose a great risk to the State of Indiana and its citizens. Tornadoes occur at any time during the day or night. They can also happen during any month of the year in any part of the State. Tornadoes' sheer unpredictability makes them one of Indiana's most dangerous hazards. Their extreme winds are violently destructive when they touch down in the region's developed and populated areas. Current estimates place the maximum velocity (combination of ground speed, wind speed and upper winds) at about 300 mph, but higher and lower values can occur. A wind velocity of 200 mph will result in a wind pressure of 102.4 pounds per square foot of surface area, a load that exceeds the tolerance limits of most buildings. When these two factors are taken into consideration, it is easy to see why these weather events can be so devastating for the communities they hit.

Another related Hazard associated with strong storms is **straight-line winds**, which can occur anywhere in the state. Severe wind gusts have caused considerable damage in the State of Indiana. They tend to occur during thunderstorms and in conjunction with super cells from which tornadoes develop. In recent years there have been events associated with these winds. While there is no formal means for tracking these events they are considered to be more common during thunderstorms than tornadoes in the damage they cause. Damage from this type of hazard tends to be more widespread and impact greater numbers of people. Because of the potential scope of this type of hazard, mitigation projects provide significant benefit in protecting lives and property for the dollars spent. These efforts are also multi-purpose, providing protection during earthquakes and tornadoes, as well as straight-line winds. For example, a common mitigation measure is to retrofit buildings to strengthen the integrity of the structure. Because these damages are normally included with tornado declarations or are collected by private insurance carriers, we will not discuss these separately from tornadoes.

Indiana has experienced many **earthquakes** within or very near to its borders. In the winter of 1811-12, the Great New Madrid Earthquakes jolted Indiana. This series of earthquakes was the largest reported in the Continental United States. The largest shocks were estimated to exceed magnitude 8.0. The power of these earthquakes caused the Mississippi River to flow backwards and change course and church bells were rung in Boston. The New Madrid Seismic Zone extends from Northwest Arkansas to Southwestern Indiana, and over 200 small earthquakes are reported every year.

The New Madrid Seismic Zone is not the only seismic area of concern to Indiana. Extending from Western Kentucky, up the Indiana and Illinois border is the Wabash Valley Seismic Zone. The Wabash Valley Seismic Zone has produced moderate earthquakes in the magnitude 5.0 range and researchers have found evidence of larger earthquakes in the magnitude 7.0 range along the Wabash River. Moderate earthquakes have occurred in recent history in 1909, 1968, 1987 and 2002. The Wabash Valley Seismic Zone is of greater concern for the Cities of Evansville, Vincennes, Terre Haute and Indianapolis.

A third seismically active area of concern to Eastern Indiana is the Western Ohio Seismic Zone near Shelby and Auglaize County Ohio. This seismic zone has had a history of producing moderate and damaging earthquakes. Geologists believe that a larger and more catastrophic earthquake could occur in this region. Cities in Eastern Indiana such as Ft. Wayne and Richmond would be affected by an event in Western Ohio. It is not a matter of if an earthquake will happen, but when. Most of the larger earthquakes that have occurred happened before Indiana had a complex infrastructure such as transportation, utilities, communications, population and economic base. Due to the infrequency of large earthquakes, these elements have not been built to withstand a catastrophic earthquake. Because of this, Indiana could expect a long and costly recovery process after an event like this.

The fourth major natural-hazard event that affects all of Indiana is **winter storms**. Indiana has repeatedly been struck by strong winter storms called blizzards. Blizzards occur when heavy snowfall is accompanied by strong winds. These conditions not only can cause power outages, loss of communication, but also make transportation of any form impossible. The “white out” conditions make visibility zero, but the resulting disorientation makes even travel by foot dangerous if not deadly. The most damaging winter storms in Indiana occur when moisture-laden gulf air converges with the northern jet stream causing strong winds and precipitation. This precipitation takes the form of freezing rain, which coats the power and communication lines and trees with heavy ice. The winds will then cause the overburdened limbs and cables to snap leaving large sectors of the population without power, heat, or communication. Although the northern third of Indiana has more and the most severe, the southern third of the state is most vulnerable as they are more adversely impacted when the severe storms strike.

Indiana must also consider the effects of **man-made hazards** on the citizens of Indiana. During the Cold War, the focus of emergency management planning was on responding to and recovering from a nuclear attack. In the 1990's this focus shifted to primarily address natural disasters. The events of September 11, 2001 in New York, and the hazardous material train derailment and fire in Baltimore Maryland, show the need to incorporate planning for these types of events into Indiana's All Hazard Mitigation Plan. In this plan, man-made hazards are those associated with technological hazards and terrorism. Technological hazards are those that refer to the origins of incidents that can arise from human activities such as the manufacture, transportation, storage, and use of hazardous materials. Terrorism refers to intentional, criminal, malicious acts. The CFR defines terrorism in the following manner "...the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives." (28 CFR, Section 0.85)

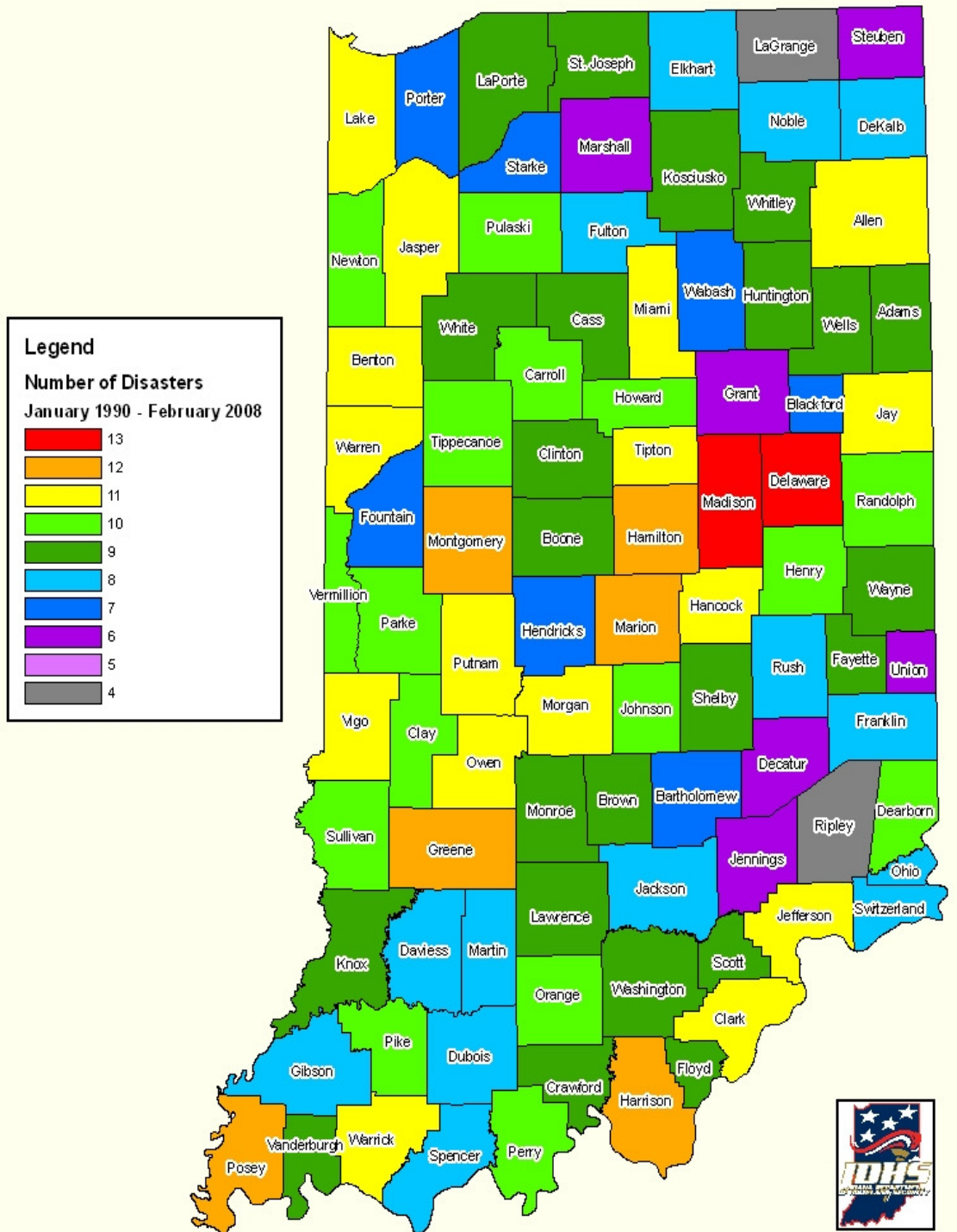
Extreme temperatures and drought could pose a slight threat to Indiana. Indiana has addressed these issues in the Comprehensive Emergency Management Plan-Drought annex. IDHS has chosen not to address these issues in their All Hazard Mitigation Plan due to the minimal occurrences that would be expected.

Increased population density with its elimination of unpaved earth and natural ground cover has also increased people's exposure and vulnerability to many hazards. Simultaneously the state's citizens have demonstrated a significant increased interest in protecting their communities from the devastating consequences of unmitigated natural hazards. As a result Indiana's mitigation strategy is designed to reduce or eliminate the risk from natural and man-made hazards without diminishing the quality of life of its citizens or their communities. Removing homes or restricting property development in the floodway or floodway fringe, thereby creating in perpetuity, green spaces, parks, golf courses and other unobstructed land are prime examples of the state's current mitigation efforts.

The chart and the map below show the type, location, and frequency of disasters in the 1990's. Most of the declared disasters are associated with flooding; however, stream and lake flooding typically does not occur without storms, and these storms usually carry strong winds, and sometimes tornadoes. Flooding from dam or levee failures can also be associated with a storm event. In the case of dams, however, flooding may occur through a sunny day failure of the dam or a component after small problems left unattended have grown into substantial problems. Flooding from a dam may also occur as a result of a terrorist incident.

Federally Declared Disasters 1990-2008				
DISASTER #	Declaration DATE	TYPE OF DISASTER	# OF COUNTIES	EXPENDITURE
DR 869	06/04/90	Flooding	20	\$10,980,692.00
DR 885	12/16/90	Flooding	1	\$2,871,285.00
DR 891	01/05/91	Flooding	67	\$6,802,309.00
DR 899	03/29/91	Ice Storm	21	\$19,979,257.00
DR 953	08/17/92	Flooding	6	\$2,725,548.00
DR 962	09/18/92	Winds, Storm, Flooding	15	\$5,228,513.00
DR 1002	09/09/93	Flash Flooding	6	\$783,237.00
DR 1109	04/02/96	Winter Storm	35	\$4,130,652.00
DR 1125	07/03/96	Spring Storms, Flooding	27	\$7,486,770.00
DR 1165	03/06/97	Ohio River Flooding	13	\$4,412,066.00
DR 1217	05/08/98	Winter Storm	8	\$5,585,824.00
DR 1234	07/22/98	Storms, Tornadoes, Flooding	23	\$12,908,434.99
EM 3135	01/15/99	Winter Storm	59	\$12,297,219.61
EM 3162	01/24/01	Winter Storm	19	\$4,797,468.31
DR 1418	06/13/02	Storms, Tornadoes, Flooding	28	\$8,415,581.61
DR 1433	09/25/02	Storms, Tornadoes	32	\$6,808,932.89
DR 1476	07/11/03	Storms, Tornadoes, Flooding	42	\$22,905,780.40
DR 1487	09/05/03	Storms, Tornadoes, Flooding	21	\$8,228,038.84
DR 1520	06/29/04	Storms, Tornadoes, Flooding	68	\$9,170,054.60
DR 1542	09/01/04	Storms and Tornadoes	20	\$2,879,545.32
DR 1573	01/21/05	Ice Storm and Flooding	62	\$30,970,827.40
EM 3238	08/29/05	Hurricane Katrina Evacuations	92	\$2,070,944.03
DR 1612	11/08/05	Severe Storms and Tornadoes	2	\$3,362,813.28
DR 1662	10/06/06	Flooding	2	\$12,084,439.56
EM 3274	03/12/07	Winter Storm	49	\$9,057,430.79
DR 1732	11/30/07	Flooding	1	\$4,486,091.09
DR 1740	01/30/08	Flooding	21	ONGOING – NO DATA
		TOTAL	468	\$221,429,755.72

Disaster Declarations by County



Public Assistance Funds Received by County

